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## Logistics sprawl in monocentric and polycentric metropolitan areas: the cases of Paris, France, and the Randstad, the Netherlands

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**Abstract.** The phenomenon of urban sprawl has been studied extensively. Most research so far has focused on residential settlements. A growing number of studies have addressed industrial deconcentration. Our focus in this paper is on logistics sprawl, i.e. the growth and suburban relocation of warehousing activities. Specifically, we investigate the difference in logistics sprawl between monocentric and polycentric systems of cities. The literature suggests that logistics activities, like residential settlements, will gradually move to suburbs as land prices increase in central areas. As research on logistics geography has mostly focused on monocentric systems, the question is whether this also applies to polycentric systems. We compare two cases, the Paris region in France, representative of a monocentric urban development, and the Dutch Randstad area as a polycentric case. We use regional statistics on warehouse settlements in both regions for a descriptive analysis of changes since the mid-2000s to derive metrics for concentration. The cases show different patterns of change. In contrast to Paris, logistics activities within the Randstad have intensified in dense areas. We explore the reasons that may explain this difference and conclude that urban structure, spatial planning policies, and the freight hub quality of a region are factors of influence.

### 1 Introduction

The recent growth of logistics activities including warehousing has increased their importance in metropolitan areas (Bowen 2008). Logistics activities are sprawling outwards and warehouses are leaving dense areas and relocating in peripheral ones. Logistics sprawl is the subject of a growing volume of research. North American metropolitan areas such as Chicago (Cidell 2010), Atlanta (Dablanc, Ross 2012) or Toronto (Woudsma et al. 2015) have been covered by pioneering work on logistics sprawl. Several studies have examined the case of Paris (Dablanc, Rakotonarivo 2010, Raimbault, Bahoken 2014). With the exception of Paris there have been few case studies in Europe.

Yet European metropolitan areas, far from forming a homogeneous whole, are characterized by long-established and variable urban forms. The literature (see below) distinguishes between two main types of urban region structure: monocentric and polycentric, which are actually the two extremes of a continuum of urban regions. Europe has a large number of monocentric urban regions such as Paris or London, but also polycentric urban regions like the Randstad region (Davoudi 2003). Polycentric and monocentric urban

regions each provide a specific urban context for the development of economic activities. Monocentric urban regions are characterized by their large and growing population and the fact that economic and leadership activities are concentrated in one metropolitan area. These factors mean that they also have a considerable capacity for growth, so, in spatial terms, they expand physically. The dense, uninterrupted, parts of a large city are easily identifiable. However, urbanized areas of its outer suburbs, which are scattered over distances of several tens of kilometers from the center, are difficult to distinguish from rural areas. The urban area includes the central conurbation and its suburban rings, which itself contain secondary centers of various sizes. This urban region has the appearance of a “macroform” (Allain 2004). Polycentric urban regions are, on the opposite, made of several urban centers, which polarize population and activities, and which are linked to each other by flows (freight, people, information) and cooperation or interdependent bounds of various types. Cities within a polycentric urban region seem to have merged in a functional and morphological entity: a large and dispersed regional urban system. Polycentric regions are characterized by the fact that residential and economic functions are distributed within the metropolis between clearly separated specialized centers of employment (Berroir et al. 2008). The residential function is organized around these centers, forming high-density clusters.

In this paper, we examine the impact of the metropolitan structure on the development of logistics spatial dynamics. We have chosen two archetypal urban regions, Paris and the Randstad, in order to take a different view on the location’s factors traditionally observed in the literature. By using the same method and the same kind of data for both areas, we want to contribute to the general debate on the location’s factors for logistics facilities. By observing the evolution of the location of logistics facilities in metropolitan areas which are located either in a monocentric urban region or in a polycentric urban region, we want to test the recurrence of the logistics deconcentration and learn from potential differences. This paper also contributes to establishing the distinction between “logistics sprawl” and “logistics suburbanization”.

The remainder of the paper is built up as follows. Section 2 provides a literature review on logistics deconcentration, logistics sprawl and the main drivers that usually explain this dynamic. Section 3 explains the data used for the analysis and the results of the comparison of the two regions and provides an interpretation of the results regarding contrasting forms of logistics urbanization in the two regions. Section 4 provides an analysis of new drivers explaining the deconcentration process in those metropolitan areas, including public policies and their potential impact on logistics spatial patterns. We conclude the paper in Section 5.

## 2 Logistics sprawl and logistics suburbanization

### 2.1 Logistics sprawl in metropolitan areas: a state of the art

Over the last thirty years, a process of metropolization has further increased urban growth and urban sprawl. Metropolitan areas have spread out because of a lack of available space in the dense parts of the conurbation (Nicot 1996) to accommodate this growth. Urban deconcentration is the outcome of the gradual saturation of the most central areas and increases in the price of land because of its relative scarcity. Logistics deconcentration, or sprawl, means an increasing number of logistics facilities in peripheral areas and their dispersion. It describes the decreasing number of logistics activities, such as warehouses, in urban centers, and their redistribution in the periphery. This is what is known as “centrifugal growth” in the typology developed by Champion (2001). What occurs is that secondary centers emerge in peripheral areas where property prices and traffic congestion are lower. These secondary centers are easily accessible thanks to high speed transport infrastructure. According to the typology developed by Le Nechet, Aguiléra (2012), Paris is a type of “pyramid” metropolis, that is to say an isotropic space in which land market forces theoretically lead to an exponential decrease in population density with distance from the employment center.

Several factors explain logistics sprawl. First, the nature of supply chain management has shifted concomitantly from “supply-push” to “demand-pull” systems (Lasserre 2004).

In the former, firms “pushed” their output into distribution channels based on demand forecasts, relying on storage places close to production sites. In the latter, firms gear their production in response to real-time information about what consumers are buying, and use distribution centers closer to consumer markets (Bowen 2008). Changes in supply chain management impacted the location of logistics facilities. Moreover, historically, the majority of these storage buildings were smaller and located in inner urban areas in the proximity of industrial areas, rail terminals, and docklands (Dablang, Rakotonarivo 2010, Cidell 2010). Changes in the location of transportation terminals also influenced the location. Because of an increasing size of facilities, large and cheap available land parcels were more likely found in suburbs and exurbs.

In a recent literature review paper, Aljohania, Thompson (2016) identifies studies showing that “land use control and the exclusion of freight in urban planning have influenced a relocation of logistics facilities from inner urban areas to suburban areas, as affordable industrial land was no longer available for logistics companies”. Nicot (1996) concludes that the lack of industrial land in inner urban areas is a primary driver in the relocation of logistics facilities away from urban cores. Merenne-Schoumaker (2008) identifies several indicators that guide the choice of location of logistics activities and warehousing establishments. First of all, land availability appears to be decisive. Distribution centers tend to require fewer and larger single-story facilities from 10,000 to 100,000 m<sup>2</sup> (“XXL warehouses”) (Hesse 2004, Cidell 2010). Consequently, suburban and exurban areas offer more affordable locations for logistics facilities. In a monocentric urban area, the price of land decreases from the center of the metropolitan area to the periphery. In polycentric urban areas, the price of land decreases for each center to each periphery, but the decrease is limited by the proximity to each metropolitan area. Suburban areas appear to be favored land for logistics facilities’ development. In order to compensate for the remoteness, logistics facilities rely on accessibility and choose to locate close to the main roads and highways, which ensure access to labor markets and consumption areas. The last factor of location, identified by Merenne-Schoumaker and also underlined by Aljohania, Thompson (2016), is the role of public policies in land use. By regulating, funding, or planning dedicated zones for logistics, public policies encourage the location of logistics facilities in determined areas. The location of logistics facilities is not only driven by market forces and land opportunities.

## 2.2 From logistics sprawl to logistics suburbanization

Land availability appears to be decisive. Consequently, suburban and exurban areas offer more affordable locations for logistics facilities. Suburban areas appear to be favored land for logistics facilities’ development. In the case of the Paris region, Dablang, Rakotonarivo (2010) showed that the parcel industry has moved to the periphery as a result of centrifugal forces. Paris infrastructure heritage initially favored the concentration of logistics and freight transport in dense central areas. Then some of these logistics activities, including distribution centers (Raimbault 2015), were transferred to peripheral areas.

In this paper, we make a distinction between ‘logistics sprawl’ and ‘logistics suburbanization.’ Logistics suburbanization has an additional qualitative meaning to the mere relative increase in the number of warehouses in areas further away from the city center. Logistics suburbanization describes the transformation of low density suburbs and the irruption/integration of logistics in the outskirts of the metropolitan area. Suburbanization can be defined as the urbanization of peripheral areas (generally with low density settlements). Spaces with lower densities provide the most attractive location for these warehouses, especially as modern warehouses are larger and in requirement of large land parcels. This development of logistics in the outskirts not only contributes to the expansion of metropolitan areas, but also reshapes the suburban areas that accommodate such activities. Logistics suburbanization corresponds to a “third phase” of logistics development (Frémont 2015). Logistics functions are discharged to external centers in the urban periphery where available space for large warehouses can meet current demand. This may present a problem not only for their spatial optimization but also for land use efficiency. Indeed, the development of logistics areas in the metropolitan fringes can promote a process of urban disintegration (Hall, Hesse 2013).

Logistics suburbanization depends on/results in a high level of goods transport. The concentration of logistics activities in the suburbs redefines the functions of both dense and suburban areas. Suburban areas become supporting territories, bases or intermediate points for the flow of goods, and often the last place before the final distribution of goods. The relationship between central and peripheral areas is linked to the flow of goods from a suburban warehouse into dense city areas.

Hall, Hesse (2013) pointed out in the conclusion of their study that the deconcentration of logistics activities as a suburban development is a “surprisingly common” phenomenon in many cities, presenting a challenge for public authorities. It seems appropriate to put this conclusion into perspective by comparing the urban structures of two very different cities. Most of the factors of location, which have been described previously, have been analyzed in the case of a single metropolitan area in a monocentric urban region. By measuring logistics sprawl in different metropolitan areas located in two different urban regions, one monocentric and one polycentric, we want to test the robustness of those factors and emphasize the importance of the structure of the urban region.

### 3 Logistics sprawl in the Paris and Randstad metropolitan areas

#### 3.1 Method and data

The urban region of Paris (the Ile-de-France region), with 12 million inhabitants on 12,000 km<sup>2</sup>, consists of nearly 1,300 municipalities. Ile-de-France is the largest consumer market in France, which demands an efficient logistics organization. The region, which represents 25% of the country’s population, and 30% of its GDP, contains approximately 20% of France’s total warehousing space. The transportation and logistics sectors account for almost 10% of employment in the region (about 400,000 jobs). Between 2000 and 2012, the Paris region experienced a 33% increase in the number of its warehousing facilities.

The Randstad region in the Netherlands, with 7.1 million inhabitants, includes 183 municipalities over 8,300 km<sup>2</sup>. It is not an administrative entity, but the product of collective construction, gradually becoming included in the Dutch planning process. The term, literally meaning “border city”, was coined in 1930 by a pilot who had noticed the peculiar urban form that extended from Rotterdam to Utrecht, surrounding a vast natural area (“Groene Hart” or Green Heart) (Kühn 2003). This term was adopted by public authorities in planning documents in the 1950s and has been steadily gaining currency since (Burke 1966). In 1966, Peter Hall (2008) described the Randstad. His notion of “metropolis” is still being debated today, for example in the most recent national planning document “Randstad Strategic Agenda 2040” (van der Burg, Vink 2008). The region is made up of four provinces (Noord Holland, Zuid Holland, Flevoland and Utrecht), which contain some of the largest cities in the Netherlands (Amsterdam, Rotterdam, The Hague and Utrecht). The Randstad represents 45% of the population of the Netherlands on 25% of its land and is the main gateway as well as goods consumption area in the Netherlands, in which respect it is comparable with metropolitan Paris. The Randstad region is a polycentric urban region clearly identified as a cultural, social, or political entity, which makes it an interesting case study.

This study aims to present comparable data for the two metropolitan areas. We used two databases: ‘Local Knowledge of the Productive System’ (CLAP) provided by INSEE (National Statistics Institute) for the French data and the Lisa database for the Dutch data. These two databases have the advantage that both use the NACE (Statistical Classification of Economic Activities in the European Community), so we can use the same categories for our comparison. We chose to use Category 52.1 “Storage”. This category applies to activities that require a logistics building, namely a warehouse. In this category, the floor size of warehouses is not specified. According to DRIEA (2009), about 20% of the warehouses in the Paris region are less than 5,000m<sup>2</sup>. Our databases also lack precision because they do not include all logistics buildings of the “warehouse” type. This is because the NACE classification only considers the principal purpose of a building, so some warehouses that serve the parcel industry or the distribution sector may not be recognized. The classification used by NACE and by extension the CLAP and Lisa databases have many shortcomings, which make it difficult to obtain an accurate estimate

of the number of establishments and their location. Because of these limitations, the final number of logistics facilities presented in this study is only an estimate of the total.

We used the aggregated number of warehouses in municipalities for the years 2004 and 2012 for Ile-de-France and for the years 2007 and 2013 for the Randstad. Although the dates are not the same, as we did not have access to the exact same year, they are quite close from each other. Both allow us to understand how the location of these facilities has changed since the mid-2000s. Another comparability problem for these data is the great difference in the size of the municipalities in the two countries. In Ile-de-France the average size of municipalities is 10 km<sup>2</sup> with a population density in each municipality of 9,000 inhabitants per km<sup>2</sup> while in the Netherlands it is 86 km<sup>2</sup> with a density of about 1,000 inhabitants per km<sup>2</sup>. To overcome this problem, we chose to use statistics for ‘cantons’ (an electoral jurisdiction) in Ile-de-France. The most rural municipalities have thus been grouped together, while those in the densest cities have remained separate. This particular division of the territory allows us to have a similar population in each division and just 286 statistical entities in Ile-de-France, which makes it possible to make a comparison between the two areas. This limitation does not fully allow us to compare the population densities and integration of warehouses in the metropolitan structure in absolute terms. We will make relative comparisons in view of the different situation in the two countries.

We have used a basic but robust spatial analysis indicator known as the centrophoric method. This allows us to measure the changes in the distribution of a statistical population (in our case, warehouses) in space and over time, through the use of several indicators. We have calculated the mean distance of the warehouses in the two regions and in each province of the Randstad (we used the provincial unit for ease of data access and processing). Each Randstad province contains a rather well defined monocentric urban structure (with the exception of Flevoland, with no major city). To measure sprawl, we used the change in the average distance of terminals to their center of gravity. We used the calculation method that is included in the ArcGIS software (Mitchell 2005). The data on warehouses is aggregated for each province of the Randstad region and for each canton for the metro area of Paris. We weighted each province and canton by the number of warehouses.

### 3.2 Measuring logistics sprawl in the Paris and Randstad regions

The first observation of interest is that at macro-level scale, the two regions have experienced a different situation regarding logistics sprawl, with a deconcentration of logistics facilities in the Paris region (+5 km) and a contraction in the Randstad region. In the same time we observed an increasing number of warehouses in the Paris region (+33%) and stagnation in the Randstad (-1%). Not only are spatial dynamics different in the two but also the state of the logistics real estate market.

The Paris metropolitan area experienced a considerable degree of warehouse deconcentration between 2004 and 2012, since the average distance of the warehouses from their center of gravity increased by 4.1 km between these two years. This finding backs up the conclusions reached by an analysis of the parcel industry from the 1970s to 2010 (Dablanc, Rakotonarivo 2010) and of all warehouses during the last fifteen years (Heitz, Dablanc 2015). Our new analysis shows that logistics sprawl has continued in the Paris region (Ile-de-France) and the Paris metropolitan area (‘Grand Paris’) between 2010 and 2012.

The second observation is the heterogeneous nature of logistics spatial dynamics in the different provinces of the Randstad. The provinces of Noord Holland and Zuid Holland underwent contraction around the center of gravity. Indeed, the average distance from the center of gravity has fallen by -2 km in the province of Noord Holland and by -1 km in that of Zuid Holland. Although this is a relatively small decrease, it shows the existence of a dynamic in both provinces during the last years. Noord Holland is the province of the City of Amsterdam, which has attracted many service activities. The province of Zuid Holland is the largest of the Randstad and contains the conurbation between Rotterdam and The Hague, with several centers.

The observed geographic patterns of change may be a result of both centripetal forces

Table 1: Spatial indicators

Time period	Regions		Metro area of Paris (‘Grand Paris’)	Noord Holland (Amsterdam)	Metro areas		Flevoland	Utrecht
	Paris Region (Ile-de-France)	Randstad			Zuid Holland (Rotterdam)			
2004-2012	2004-2012	2007-2013	2004-2012	2007-2013	2007-2013	2007-2013	2007-2013	2007-2013
Area (km <sup>2</sup> )	12,012	8,357	657	2670	2818	1419	1450	
Population (million)	11.9	8.5	4.5	2.7	3.6	0.4	1.2	
Number of warehouses	955	583	441	278	185	59	61	
(most recent year)								
Number of warehouses	713	589	388	318	168	60	43	
(most ancient year)								
Change in number of	+34	-1	+14	-12	+10	-2	+42	
warehouses (%)								
Logistics sprawl	5	–	4.1	-2	-1	3.3	0.5	
indicator (km)								



and centrifugal ones at the Randstad level. Logistics sprawl at the Randstad regional level may translate into concentration or deconcentration at the local scale (for each metropolitan area). The Randstad region experienced a dispersion of logistics activities in the 1970s when they moved from clusters to peripheral regions within the Netherlands (Davydenko et al. 2013). Nevertheless, our analysis measures these patterns in more detail and, also seems to suggest a coordinated move of centers of gravity towards the “Groene Hart”, i.e. sprawl into the heart of the ring-shaped Randstad area, along the direction of the main highways connecting the cities. The provinces of Zuid Holland and Noord Holland have a different situation regarding the evolution of the number of warehouses. In the province of Zuid Holland the number of warehouses has increased by 10% while the number of warehouses has fallen in the province of Noord Holland by 12%. The absence of logistics growth and of logistics sprawl in Noord Holland means that Amsterdam metropolitan area as a logistics cluster is shrinking. Meanwhile, logistics facilities are growing inside the dense part of the Rotterdam metro area.

The deconcentration of warehouses is a confirmed pattern in the provinces of Utrecht and Flevoland. The province of Utrecht is small and polarized by the city of Utrecht. Flevoland province is slightly different from the others: it does not include major cities such as Amsterdam and Rotterdam nor major transport infrastructures, and in historical terms it is a recent creation. It cannot therefore be considered as an urban center in the same way as the others, but it is the subject of many proactive development policies, particularly for its new town of Almere. The deconcentration of warehouses is taking place in the provinces of Flevoland (+3.3 km) and Utrecht (+0.5 km), although the intensity of the process is not the same, being relatively low in the province of Utrecht compared with Flevoland. We can hypothesize that the significant deconcentration taking place in the Flevoland province is linked to the recent nature of its development.

By using the centrophraphic method, we have been able to determine whether warehouses have expanded or contracted around the urban centers. While it allowed us to observe the expansion of logistics activities in metropolitan areas, it did not allow us to say whether there was a pattern of logistics suburbanization, as we defined it above. We must supplement this discussion with an analysis of the integration of warehouses in relation to the density of metropolitan areas.

### 3.3 Measuring logistics suburbanization

To measure logistics suburbanization, we have established a profile for each municipality for the Randstad and each statistical canton for Ile-de-France, according to two criteria: firstly population density, and secondly the number of warehouses, which to some extent reflects logistics intensity. We have used the same data as before: the number of establishments classified as “warehouses” in the CLAP data for Paris and the Lisa data for the Randstad. These municipal (or cantonal) profiles were prepared using quartile-based discretization for each of the studied variables (population density and number of logistics facilities). This gave sixteen profiles. For ease of understanding we have grouped these profiles together to form four major types (see Table 2 and Figure 1).

Once the profile of each municipality has been assigned to one of the four possible types, we have calculated which profiles are overrepresented in order to identify the dominant patterns in each metropolitan area and obtain a specific picture of logistics sprawl (Figure 1). The cantons corresponding to the profile “A” have a population density of 11,687.5 inhabitants/km<sup>2</sup> in the Paris region compared with 594 inhabitants/km<sup>2</sup> in the Randstad. The profiles at each date and the way they have changed show the pattern of logistics sprawl that has taken place in the metropolitan areas.

Figure 1 shows how logistics activities are integrated within the metropolitan areas of each region and how they have changed over time.

In the case of Paris, the overrepresented profiles were types A and D in 2004, while in 2012 it was types B and C. In recent years, more warehouses have been set up in suburban towns than in municipalities with a higher population density. We do observe logistics suburbanization in the Paris region. This observation concurs with the work of Raimbault, Bahoken (2014) on logistics suburbanization. Logistics activities are declining in the densest areas and tending to favor less dense areas in the outer suburbs or the first



Table 2: Typology of municipality/canton profiles

Profile	Type	Description
A	Logistics in dense areas	High population density High number of logistics establishments
B	Logistics in suburbs	Low population density High number of logistics establishments
C	Residential zones	High population density Low number of logistics establishments
D	Rural zones	Low population density Low number of logistics establishments

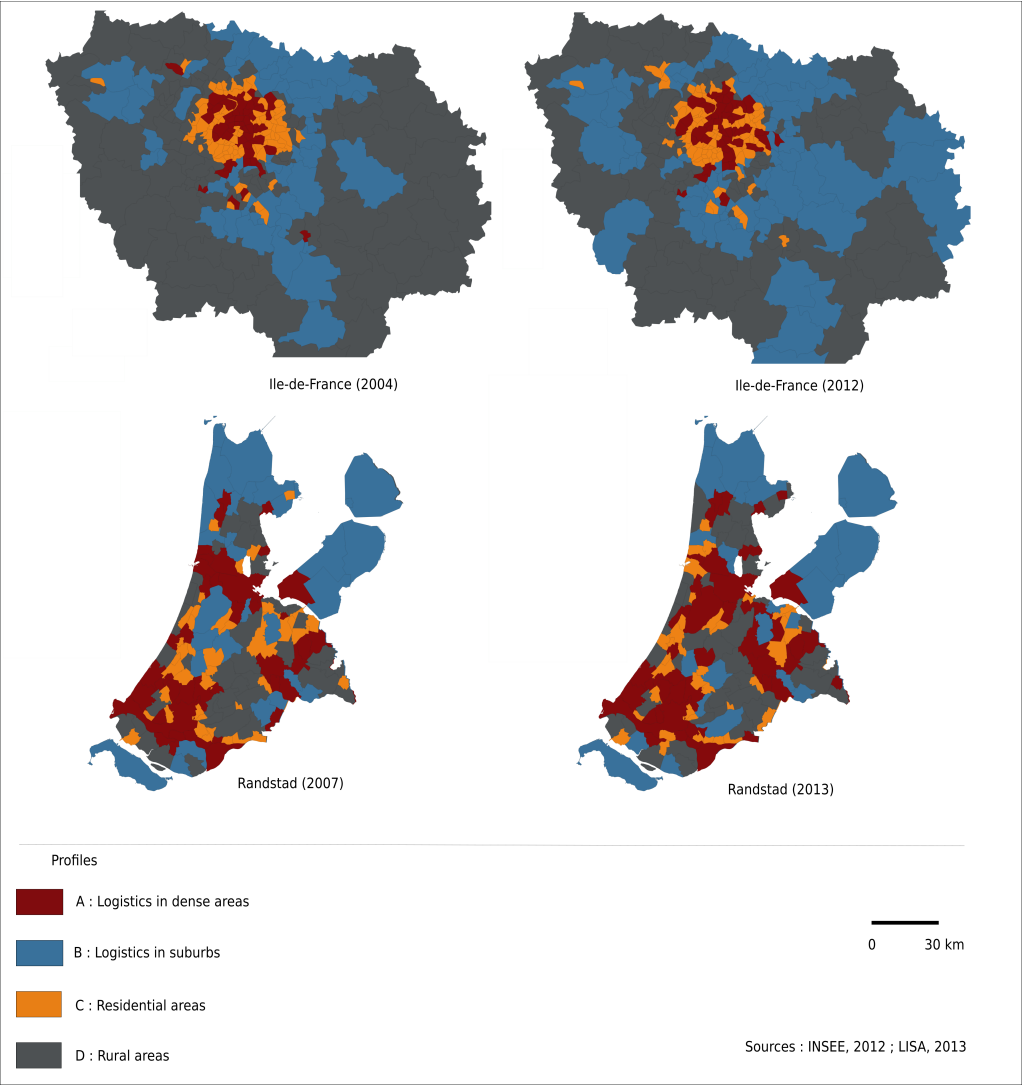


Figure 1: Comparison between local profiles in the Paris and Randstad regions

suburban ring. Logistics sprawl in metropolitan Paris has the effect of strengthening and densifying peripheral areas. The change in the location of the warehouses results not only in the expansion of the metropolitan area but also the increasing presence of logistics in the outskirts, in less densely populated areas.

In the Randstad region, municipalities with types A and D profiles dominate, both in 2007 and 2013. This means that logistics activities continue to locate in the dense areas of the region. Logistics suburbanization is much weaker than in Paris.

What is particularly striking in the analysis of the integration of warehouses in the metropolitan structure of Paris is the change in the location pattern between 2004 and 2012. Over this short period, there was a profound change. Logistics activities today seem to locate mainly in the suburbs where their numbers are growing. This analysis reveals that the warehouse location pattern goes beyond the deconcentration of logistics activities: logistics suburbanization is the dominant model. In contrast, in spite of the deconcentration of warehouses in certain urban conurbations, the Randstad exhibits weak logistics sprawl as well as logistics suburbanization, focused towards the inside of the ring-shaped region. Its dense areas have remained the prime location for logistics activities.

In recent years, modifications in the location of warehouses have generated spatial and morphological changes in cities (Frémont 2015). Overall, logistics facilities in the Paris and Randstad regions have become more dispersed. At the metropolitan scale, the Rotterdam and Amsterdam metro areas have an atypical profile and their warehouses have concentrated. They have not experienced logistics decentralization. In metropolitan Paris, the number of logistics sites has increased in peripheral areas to the detriment of the central areas, which means that logistics urbanization takes the form of logistics suburbanization. In summary, the case of the Randstad reveals the existence of a different form of logistics urbanization, logistics intensification, which we will discuss in the next section.

In section 2 we have identified different factors of relocation of logistics facilities mentioned in the literature. To explain the different forms of logistics locational patterns between the Paris and Randstad regions, we look at some of these factors in more detail.

#### **4 Analysis of drivers explaining locational patterns: logistics suburbanization vs. logistics intensification**

##### *4.1 The provision of airports and large logistics clusters*

Logistics facilities often tend to locate within logistics clusters in the fringes of metropolitan areas close to major airports and seaports or even highway networks (Hesse 2002, Woudsma et al. 2008, Cidell 2011, Allen et al. 2012). A freight transport system mainly performed by trucks contributes to logistics sprawl. In the Paris region, 90% of goods (in tonnes) are carried by road. Road accessibility is one of the most important factors of relocation of logistics facilities in the suburbs. Distance to the center is compensated by accessibility. A first movement of decentralization of transport infrastructure such as freight rail facilities in the 1960s and 1970s took away some logistics facilities from city centers to peripheral areas (Beyer 1999). In Paris, the development of logistics activities in peripheral areas is in part explained by the location of major transport nodes in these areas: Roissy and Orly airports, the river ports of Gennevilliers and Bonneuil, for example. These nodes still retain large clusters of warehouses (Heitz, Dablanc 2015). It so happens that the three major clusters in the innermost suburbs to the north (Gennevilliers), northeast (Roissy, Mitry-Mory) and south (Orly and Bonneuil) are also the main gateways for national and regional freight. These clusters are located in the peripheral areas. In the case of Paris, the location of nodal transportation infrastructure is an important factor of relocation of logistics facilities.

The Randstad region contains the port of Rotterdam, which is the largest (in terms of freight traffic) maritime port in Europe, and the Amsterdam Schiphol airport which is the fourth largest in Europe. The port of Rotterdam and its entire region are integrated in port regionalization dynamics, which means that logistics activities spread out into the region. Many activities are functionally linked to the port, and spread over a region that

stretches from Dordrecht to Venlo through Tilburg (Priemus, Visser 1995) crossing the boundaries of municipalities and provinces (van der Burg, Vink 2008). However, it seems that this dynamic has been reversed in the provinces of Noord Holland and Zuid Holland in the last fifteen years. This observation allows us to appreciate how quickly the location of warehouses can change. The port of Rotterdam and Schiphol airport are the two most important logistics clusters in the Randstad (OECD 2007) and therefore naturally have a high concentration of warehouses and other logistics activities. In Zuid Holland in recent decades the port of Rotterdam has sought to limit its spatial expansion. The port of Rotterdam has decided to promote logistics development in the vicinity of port infrastructure. The Havenplan 2010 Port Development Plan emphasized the importance of limiting the space taken up by port development with the construction of the Second Maasvlakte, a polder in the North Sea near Rotterdam, and the relocation of activities (Priemus, Visser 1995). The decision to build this landfill was taken in 2004 and the facility was opened in 2013, thereby halting the expansion of the port towards the city and allowing re-urbanization of industrial areas. In anticipation of increased activity in the port, logistics activities have been redistributed around the port in recent years. The intensification of logistics reflects the existence of a new clustering of logistics activities highlighted by van den Heuvel et al. (2013).

Among the main factors for the development of logistics activities in the suburbs is a need for accessibility. Therefore, a possible explanation of logistics intensification is the severe congestion facing the area on the roads that connect the major urban centers. “Road congestion in the Netherlands is one of the most urgent problems facing the Port of Rotterdam, as it increases and decreases delivery time reliability for logistics companies that have chosen to use Rotterdam” (OECD 2007). Congestion can be a factor that limits logistics sprawl if its cost becomes excessive.

#### 4.2 *The role of public policies on logistics locational patterns*

Dablanc, Raimbault (2015) argue that, despite attempts to achieve regional organization, the institutional fragmentation of metropolitan areas in France and the US lets “the laws of a dynamic land market and the most local level of government decide the location of logistics facilities” (p.301). A new logistics real estate in the outskirts of metropolitan areas reinforces the suburbanization of logistics, closely related to a lack of planning at the metropolitan level. With a long tradition of planning to address urban sprawl (Bogaerts et al. 2007), Dutch planners have de facto limited the sprawl of economic functions at a metropolitan scale. Suburban development took place in “quite a deconcentrated manner along the highways, at infrastructure nodes and on designated sites” (Bogaerts et al. 2007), but always limited by the “Groene Hart”. Logistics deconcentration, as a result, appears to be quite limited in comparison with Paris. At the metropolitan scale, centripetal forces remain important, encouraged by policies focused on transport infrastructures, and logistics activities decentralize mostly along the highways. The polycentric region of the Randstad, overall, favors logistics concentration.

It is our hypothesis that this concentration is reinforced by public policies at the local and metropolitan levels. Public policies in the Netherlands have traditionally mainly focused on (1) developing the position of the Randstad as a hub for distributing goods across Europe; and (2) protecting the region’s environment and contributing to the efforts against climate change. In the vision entitled “Randstad Holland in 2040” (Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieu 2008), the government set out its plan to make the Randstad into a “sustainable, competitive top European region”, considering the metropolitan region as a whole, which must become more homogeneous. With the plan “Randstad Holland in 2040”, public authorities want to group together the “city regions” which are unequally developed, to form a coherent morphological and functional entity. This may help promote logistics intensification in the region. In Paris likewise, public policies have recently considered logistics sprawl. The recent regional master plan (SDRIF 2013) recommends the preservation of logistics activities in dense areas of the region and the promotion of tools to accommodate new logistics activities in the central areas. The new Paris municipal zoning code (Ville de Paris 2016) identifies more than 80 central city locations reserved for future logistics activities.

The Netherlands has a long tradition of urban planning. From the 1950s to the 2000s, a specific idea of the Randstad has predominated in the planning of the region influencing the location of economic activities. In 1958, the Randstad was defined as a group of “city regions” arranged in a horseshoe shape and separated by natural buffers including a large central green area. Urbanization is concentrated in the main urban centers and along the main roads connecting them ([Rijksdienst voor het Nationale Plan 1958](#)). The history of planning in the Randstad consists of successive policies promoting the development of compact cities and limiting urban sprawl by controlling the development of activities and the population on the region. In 1993, the Dutch Parliament adopted the “Supplement to the Fourth Policy on Territorial Planning”, or VINEX. By favoring a compact city model, the Parliament tried to regulate mobility, increase the capacity of urban infrastructure, and protect natural spaces, for example with the ABC location policy (“ABC-locatiebeleid”) ([Bogaerts et al. 2007](#)), which intended to plan the location of trip generators such as businesses, services, and industry. The location of economic activities was reorganized on the basis of the number of jobs in order to maximize the use of public transport. Activities involving fewer jobs and greater dependency on motorway access, such as warehouses, were encouraged to move to the outskirts, reserving the most densely populated areas for office type activities. The ABC location policy was then updated by policies that encourage the concentration of activities, including activities with lower density of jobs such as logistics. If the efficiency of these policies has been discussed, the Dutch planning system leaves considerable room for local spatial policy initiative and power.

Therefore, we could make the hypothesis that the concentration of warehouses around the main urban centers is a direct consequence of the desire of the Dutch government to encourage the concentration of urbanization. At the local level, the development of each urban center is a way of achieving a balance in the region. The project to develop the Randstad as an institution also aims to make a coherent area, based on a functionalist approach to space and on a division of functions between the economic centers in order to make them more specialized, intensify their activities, and improve their connectedness ([van der Burg, Vink 2008](#)). Rotterdam was identified as the main hub for the development of logistics and freight transport, Utrecht as a university center, The Hague as a political cluster that focuses on international law, and Amsterdam as the capital city, retaining the role of a multifunctional center. This distribution of functions is based on a particular concentration of economic activity around the various centers, especially around each of the major transport hubs, for example the ports of Rotterdam and Amsterdam or Schiphol airport.

We argue that logistics intensification may be partly due to the Randstad urban region’s structure (polycentrism) and partly due to the public policies of concentration and preservation of green spaces. Parallel to these, ‘relative densities’ between urban centers and suburban areas may also be identified as an explanatory variable: a hypothesis can be that when the difference in density levels within a metro area is relatively minor, the availability of land or the differences in rental prices are not strong incentives to site a warehouse out of an urban center. A comparative analysis of densities and warehouses’ rental prices in our two urban regions is still required to conclude on that matter.

While logistics sprawl has occurred in some provinces in the Randstad region, warehouse development in peripheral areas has not taken place at the expense of dense areas across the region. The dynamic expansion that we have described corresponds to logistics facilities’ decentralization but it has not led to logistics facilities in peripheral areas dominating those in dense urban centers. In Amsterdam and Rotterdam metro areas logistics activities relocated around urban centers. This situation continued to apply between 2007 and 2013. Despite the presence of a strong sprawl dynamic affecting warehouses in the provinces of Flevoland (The Hague) and Utrecht, logistics is overall well integrated within dense areas. We can assume that The Hague and Utrecht have been experiencing logistics development later than Amsterdam and Rotterdam, and that logistics sprawl there is related to suburban sprawl. Overall, the Randstad example shows that dense areas can remain attractive for logistics activities. Analysis of the spatial dynamics in the Randstad reveals above all the existence of a form of urban logistics in which logistics activities

remain a permanent feature of dense areas and in which areas of medium density undergo development. This can be called “logistics intensification”.

Two forms, at least, of logistics urbanization coexist in metropolitan areas in Europe: logistics suburbanization and logistics intensification. In the case of the Paris region, logistics sprawl leads to logistics suburbanization, meanwhile the Randstad region experienced logistics contraction and densification. Public policies can explain some of the differences between logistics suburbanization and logistics intensification.

## 5 Conclusion

It has been observed in the literature that in many of the world’s cities the development of logistics facilities has taken place in the outskirts as part of a process of logistics sprawl. However, it is noteworthy that most of these analyses were made in the case of monocentric urban regions, which contain one central urban area, highly developed suburbs, and less developed exurban areas. By analyzing changes in the location of warehouses in the polycentric Randstad region between 2007 and 2013, we highlighted the existence of another “model”. Logistics intensification has occurred in the main urban areas (Rotterdam and Amsterdam) of the Randstad, with different distribution densities and center/suburb relationships. We have shown that each metro area of the Randstad has its own dynamic in terms of logistics. In the Randstad, logistics activities and warehouses tend to concentrate in (close to) metro areas, and we may relate that to its polycentric structure as well as (under links that remain to be specifically analyzed) its situation as a European freight hub and gateway. The specific tradition of land use control in the Randstad may also explain the intensification of logistics development in or close to the urban areas.

The different forms of logistic urbanization reveal a variable level of warehouse integration in metropolitan structures. Logistics activities are not condemned to “flee” into the suburbs. Under certain conditions, these activities can stay in the denser parts of a conurbation. We therefore formulate as a general conclusion that the diversity in the forms taken by logistics development is not simply due to the logistics and freight transport system, but also depends on the intrinsic characteristics of the regional spatial structure as well as local planning and land use policies.

This research cannot provide a final conclusion on the different types of logistics spatial developments according to the monocentric or polycentric nature of an urban region. In our two cases, the Paris region and the Randstad region, the intensification of logistics reflects a polycentric urban region while logistics suburbanization appears to be a symptom of a monocentric metropolitan area, but other factors, as we have shown, have played a role. This work is a starting point. What remains to be done, and could be relevant for a subsequent research about polycentric urban regions, is to look at freight and logistics interdependencies (freight flows to and from warehouses, main freight generators and consumption areas) between the four different provinces of the Randstad.

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